

and long accepted familiar names in any branch of natural history, resulting as it does in constant confusion and discouragement, especially to the uninitiated."

Letters without an expression of opinion were received from Henry B. Bigelow, A. J. Jukes Browne, William E. Hoyle, and Charles Wardell Stiles.

Finally, one card from Dorchester, England, read "I am in favor of accepting *Encrinus* Schulze, 1760 . . . but I should prefer a postal order for five shillings to be sent to

Timothy Scroggins, Warwick Gaol, and to be given me when I have finished my time."

Since this poll was taken the principle of prescription has been adopted by the International Commission on Nomenclature, and a list of *nomina conservanda* has been established.

All the cards and the letters referred to above have been mounted in a scrapbook, which is filed in the Library of the Smithsonian Institution.

ZOOLOGY.—*On Polyclinum indicum, a new ascidian from the Madras coast of India.* V. O. SEBASTIAN,¹ University Zoology Research Laboratory, Madras, India. (Communicated by Fenner A. Chace, Jr.)

While engaged in a study of the ascidian fauna of Madras coast, I was able to identify a new species of *Polyclinum*, the structure of the zooid, larva, and postlarval stages of which forms the substance of the present paper. Herdman (1891) has described *P. constellatum* and *P. isiacum* from the Indian Ocean, and a doubtful species (1906), *P. nigrum*, from the gulf of Manaar. Sebastian (1942) has published an account of the anatomy and larval organization of *Polyclinum* sp. obtained from a dredge collection off the coast of Madras and later (1952) described as *P. madrasensis* Sebastian. The present form, ***Polyclinum indicum***, n. sp., is the commonest synascidian found along the rocky shores of the Madras coast. The colonies are found attached to the under surface of stones and boulders, at the level of the tides, on the Royapuram coast, north of Madras harbor. The places where they grow are always subjected to the action of violent waves.

External appearance.—The colonies vary in shape, younger ones being oval or pear-shaped with narrow bases of attachment and round upper exposed surfaces (Figs. 1, 2). The full-grown colony has an umbrella-shaped upper exposed surface, the base of attachment being broader, but narrower than the diameter of the upper region (Fig. 3). The mature colony has a diame-

ter of 2 to 2½ inches, and a height of 1½ to 2 inches. The common cloacal openings are found scattered on the exposed surface, raised on conical projections of the outer test. The surface is encrusted with a thin layer of sand. The color is light brown or pale red in the majority of cases. Rarely the color is dull green, but except for this the anatomical features are the same. Several colonies, large and small, could be seen closely applied to one another, the different-colored colonies occurring in the same group.

The zooids are arranged in systems of about 20 to 40, three or more such systems found around one common cloacal opening forming a pattern (Fig. 4). The branchial openings have a whitish color on their margins. A cross section of the colony (Fig. 5) shows the disposition of the zooids inside the test. They are arranged toward the outer periphery, their long ampullae running throughout the length of the test in various directions. The test is transparent, having a tinge of either red or green according to the color of the colony.

Structure of zooids.—The length of the zooid (Fig. 6) from the branchial siphon to the tip of the postabdomen is about 2.3 to 3.2 mm. The abdomen is about one-half and the postabdomen three-fourths the size of the thoracic region. The shape and proportion of the various regions of the zooids may vary slightly according to the manner in which each zooid is pressed into the group forming a system. The *branchial siphon* is 6-lobed. The *atrial siphon* is a wide space exposing a part of the branchial sac, which is a characteristic feature. At the anterior edge of the atrial siphon there is an *atrial languet*, which is leaflike, but

¹ I wish to express my thanks to Dr. C. P. Gnanamuthu, director of the University Zoology Research Laboratory, for his helpful suggestions, and to the authorities of the Madras University for varied assistance rendered.

the distal extremity is blunt with a few protuberances. The size and shape of the languets vary according to the distance of the zooid from the common cloacal opening, those farthest being longer and more pointed, those nearest, shorter and blunt. The languet appears to be the enlarged anterior lobe of the opening, the other lobes having failed to develop to their full size. Rarely vestiges of the other lobes are also seen (Fig. 7). The *muscle bands* are six pairs on the mantle wall, extending only up to about the middle of the thoracic region.

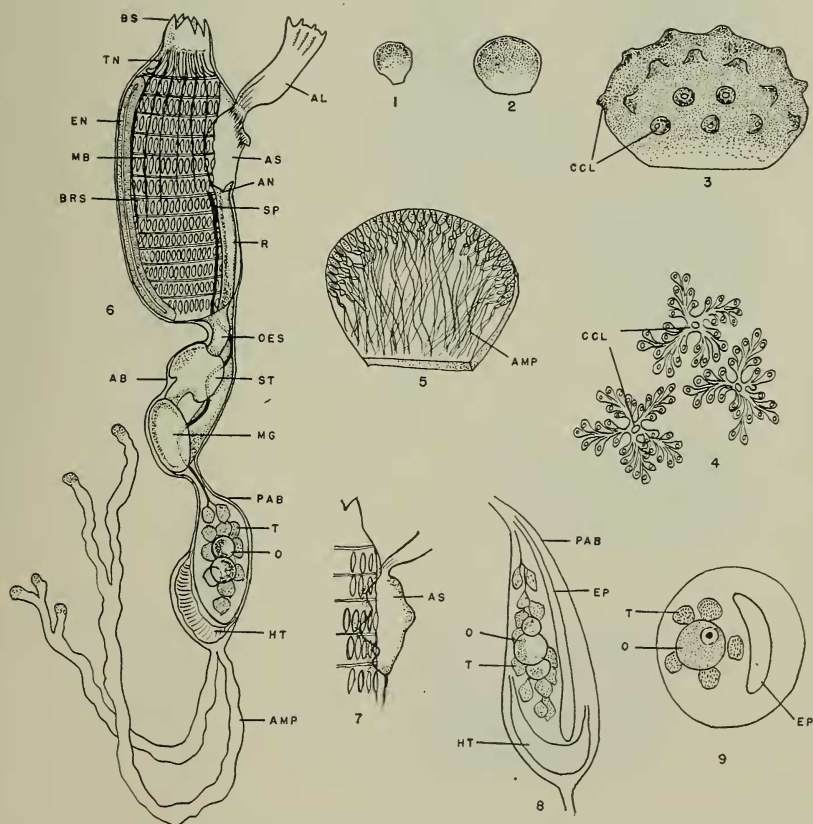
The *thorax* is cylindrical. There are about 13 to 15 rows of stigmata, with 14 to 16 elliptical stigmata in each row. In smaller zooids the number may vary from 12 to 14. Each transverse vessel bears a series of minute papillae on its inner free margin. The *dorsal lamina* is in the shape of languets. The *tentacles* are simple varying from 12 to 16, their free ends being slightly swollen.

The *abdomen* when viewed as a whole is kid-

ney-shaped. There is a funnel-shaped *esophagus*, followed by a *midgut* and *rectum*, the whole system bent and twisted into a U with unequal limbs. The rectum opens at the posterior edge of the atrial siphon, the anal opening situated between two lobes.

The *postabdomen* is connected to the abdomen by a short narrow stalk which gradually widens to hold the gonads and heart. The *testis* consists of follicles in the shape of bunches of grapes all connected together by narrow ducts. The *ovary* is found to occupy the middle portion among the mass of sperm bunches, and shows eggs of various sizes. The sperm duct and oviduct run together and open near the level of the rectal opening. Posterior to the gonads and slanting in disposition is the *pericardium* enclosing the *heart*. A thin-walled *epicardium* runs along the side of the gonads (Figs. 8, 9): its posterior extremity comes to the middle bend of the heart.

Sexual reproduction.—Eggs undergo development inside the atrial chamber, and tadpole lar-

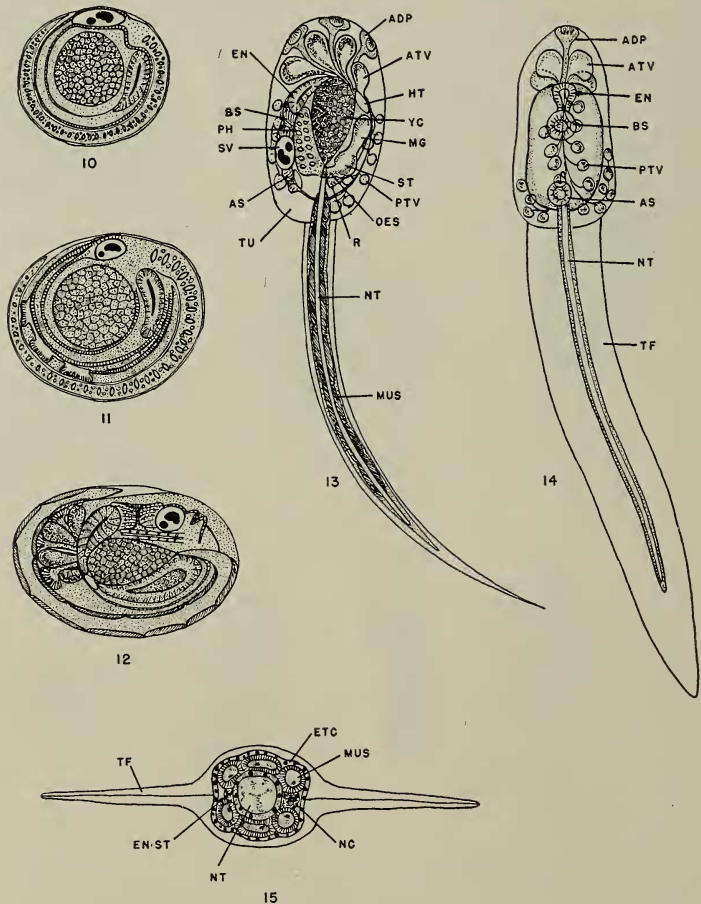


FIGS. 1-9.—*Polyclinum indicum*, n.sp.: 1, 2, Young colonies; 3, mature colony; 4, surface view showing the grouping of zooid systems; 5, a thin solid section of a colony; 6, mature zooid; 7, atrial siphon with vestiges of lobes; 8, postabdomen; 9, cross section of postabdomen.

vae when mature are liberated in swarms. Breeding occurs throughout the year. Colonies collected and kept in troughs of sea water liberate larvae at any time of the day. The egg measures 0.25 mm and has a yellowish tinge due to the presence of yolk. A few stages of developing embryos are shown in Figs. 10-12.

Tadpole larva.—The tadpole (Fig. 13) measures 1.66 mm from the adhesive papillae to the tip of the tail fin, the trunk measuring 0.32 mm and the tail 1.34 mm. The *tunic* covers the whole body and tail of the larva. In the region of the tail, the tunic is expanded into the tail fin, which is horizontal in position owing to the rotation of the tail (Fig. 14). *Test vesicles* (“tunic vesicles,” Scott '46) are of two sets, one directed anteriorly and the other posteriorly. The anterior ones are club-shaped and arranged in a ring of eight in two rows of four each, arising from the anterior ectodermal margin of the body of the larva, and

spreading out with a slant toward the dorsal side. The middle two pairs are longer, measuring 63.2 μ , and the lateral ones smaller, measuring 47.4 μ . The posterior test vesicles are in the nature of bunches of grapes, one set dorsal and one ventral in position, with long narrow tubular stalks from which arise pinnately arranged branches ending in round hollow vesicles containing mesenchyme cells. They are of ectodermal origin, the stalks arising from the anterior margin of the trunk, from their respective dorsal and ventral sides, at the level of the origin of the anterior test vesicles. *Adhesive papillae* are three in number and arise from the anterior ectodermal margin of the trunk between the ampullae. Each one of them has a long narrow tubular stalk, the distal extremity of which swells into a goblet containing a central mass of columnar secretory cells, all converging to a point in the central opening (Fig. 19). Grave (1921) has stated that the



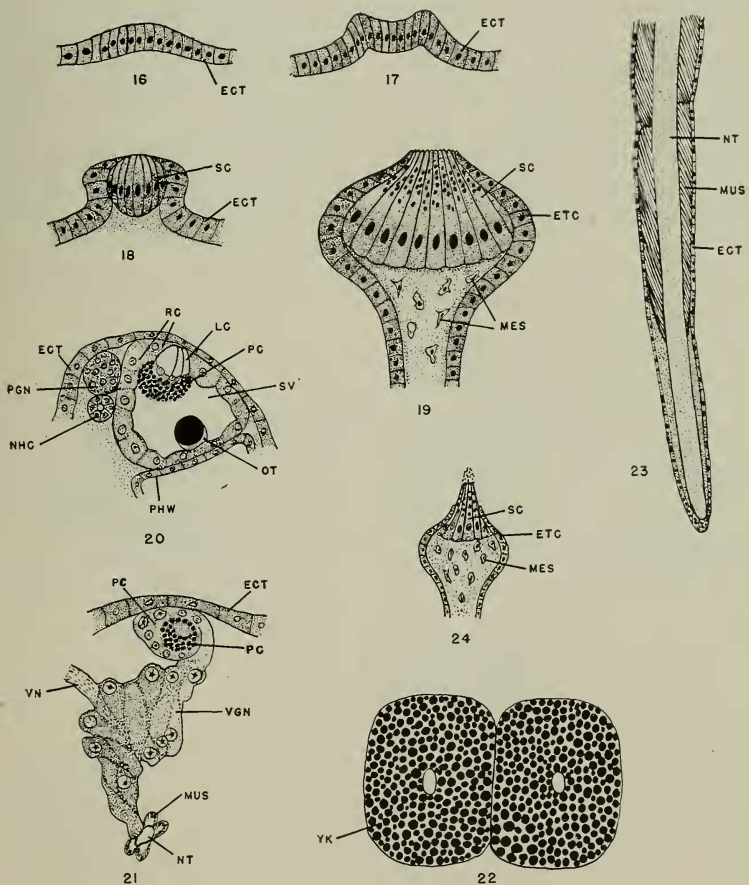
FIGS. 10-15.—*Polyclinum indicum*, n.sp.: 10-12, Developing embryos; 13, tadpole larva, side view; 14, tadpole larva, dorsal view; 15, Transverse section of tail of larva.

secretory cells of the adhesive papillae in *Amaroucium constellatum* are modified mesenchyme cells. Sebastian (1942) has found them to be of ectodermal origin in *Polyclinum* sp. (*P. madrasensis*), formed by the intucking and elongation of the ectodermal cells of the papillae, similar to the condition found in the cement glands of certain fishes and amphibian larvae (Asheton, 1896; Jones, 1937; Bhaduri, 1935). Scott (1946), studying the larval organization of *A. constellatum*, has also found that these cells are of ectodermal origin. The same kind of ectodermal origin of the secretory cells of the adhesive papillae in *P. indicum* is illustrated in Figs. 16-19. The mantle or ectodermal covering of the body and tail is made up of one layer of cells with distinct nuclei, containing a large number of yolk granules. The layer covering the trunk has cubical cells which gradually become thinner and flattened in the

tail region. In the region of the branchial and atrial siphons these cells are columnar.

The nervous system consists of the sensory vesicle with the contained ocellus and otolith, visceral ganglion with the visceral nerve, and nerve cord, of the larval action system, and the permanent ganglion and hypophysial duct of the adult system (Figs. 20, 21). The sensory vesicle is situated between the branchial and atrial siphons to the right side. The ocellus consists of three lens cells, pigmented optic cup and associated retinal cells. The otolith is single-celled with a perfectly spherical pigmented mass at its distal end.

The digestive tract (Fig. 13) is a bent tube including the pharynx, esophagus, intestine, and a short rectum, which ends blindly near the level of the esophagus. There is a middle mass of yolk cells, conical in shape, the narrow portion being connected with the endodermal layer by a short



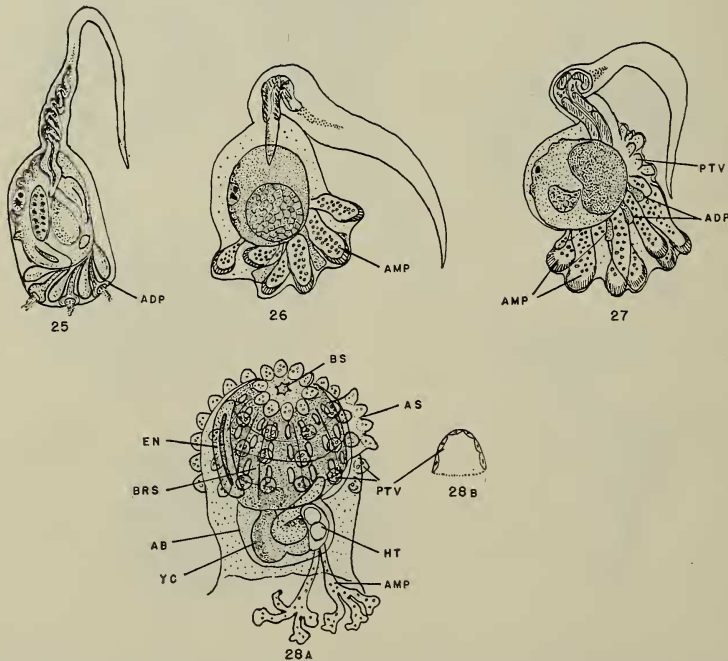
FIGS. 16-24.—*Polyclinum indicum*, n.sp.: 16-18, Stages in the formation of the secretory cells of adhesive papillae; 19, goblet magnified; 20, sagittal section through the region of the sensory vesicle; 21, section passing through the visceral ganglion; 22, Transverse section of yolk cell mass; 23, magnified view of the posterior extremity of tail of larva; 24, secretory cells of the goblet being shot out.

stalk. In transverse sections it is found to be formed of two squarish portions (Fig. 22), each having a narrow central cavity. The *endostyle* is placed on the anterior margin of the pharynx, one edge of it touching the anterior edge of the yolky mass. The pharynx has two rows of stigmata on each side, each row having about eight stigmata. On the ventral side of the yolky mass toward the anterior side is situated the *pericardium* and *heart*.

The *notochord* forms the central core of the tail (Fig. 15); it has 40 cells placed one behind another in a row. In the full-grown larva the boundaries of notochordal cells are not clearly seen. Owing to the twist of the tail at an angle of 90° to the left the nerve cord is found on the left and the *endodermal strand* on the right side of the notochord. The muscle bands situated dorsally and ventrally do not extend up to the posterior extremity of the notochord (Fig. 23). Each band is formed of three rows of muscle cells, each row of seven cells, placed one behind the other. There are only two rows of cells on the portion of the notochord which projects into the body. The muscle cell has a darkly staining cortex, and an inner vacuolated core with cytoplasmic strands and nucleus. The disposition of the striations is oblique, as described by Grave (1921), Conklin

(1931), Scott (1946), and Berrill (1947). The ectoderm of the tail forms the outer covering of the muscles.

Metamorphosis of the larva.—The free-swimming period lasts 5 to 8 hours. At the time of fixation the secretory cells of the adhesive papillae shoot out of the goblet, exuding their secretory product (Figs. 24, 25). The tail gets resorbed, and the anterior ampullae elongate and spread out in an irregular way (Figs. 25–27), attaining their maximum length of 0.24 mm in 2 hours after the tadpole has become fixed. The heart begins to beat after 3 hours, the siphons contract after the fifth hour, and the intestine functions 10 hours after fixation. Complete resorption of the tail does not take place in most of the cases during the changes described above. At least a quarter of the original length, and in some cases even half, of the tail remains unchanged for about 12 hours, and in certain cases for more than 24 hours. The posterior ampullae do not disappear immediately after metamorphosis. They enlarge in size and remain all over the surface within the tunic as pyramidal projections (Fig. 28a, b); their walls are made up of a very thin unicellular layer. The ducts that connect them are not found during this time. These vesicles are clearly visible for a week or more, later



FIGS. 25–28.—*Polyclinum indicum*, n. sp.: 25–27, Stages in the metamorphosis of tadpole larva; 28a, a functional oozoid, 48 hours old; 28b, magnified view of a single posterior test vesicle.

disappearing by bursting and releasing the mesenchyme cells lodged inside them. Under laboratory conditions it has not been possible to keep alive the metamorphosed stages for more than 10 to 13 days; the size attained in 4 to 5 days remains without any change for the rest of the days. The abdomen descends partially (Fig. 2Sa), but the descent of the postabdomen has not been observed.

Validity of the Species.—Zooids as well as larvae of *Polyclinum* are alike, differentiating characters being minor. Berrill (1950) remarks that "in zooid structure, though less so in form of colony, species of *Polyclinum* are very much alike, and even the tadpoles and larvae appear to differ only in size." Van Name (1945) says that "the true *Polyclinum* are all very closely related to each other, their zooids apparently having nearly the same structure, so that we must depend chiefly on the gross characters of the colonies for distinguishing them. A supposed difference in the number of branchial tentacles (whether in multiples of 4 or 6) appears to be of questionable value as a specific character, multiples of 6 being probably normal, though subject to irregularities." The present species closely resembles *P. planum* in shape and number and rows of stigmata, but it differs in the shape of the atrial siphon, the atrial languet and the slanting disposition of the heart. On account of these differences the present form is given the status of a new species, *P. indicum*.

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KEY TO LETTERING ON FIGURES

AB, abdomen; ADP, adhesive papilla; AL, atrial languet; AMP, ampulla; AN, anal opening; AS, atrial siphon; ATV, anterior test vesicle; BS, branchial siphon; BRS, branchial sac; CCL, common cloacal opening; ECT, ectoderm; EN, endostyle; EN.ST, endodermal strand; EP, epicardium; HT, heart; LC, lens cell; MB, muscle band; MES, mesenchyme cells; MG, midgut; MUS, tail muscle; NC, nerve cord; NHC, neurohypophysial canal; NT, notochord; O, ovary; OES, oesophagus; OT, otolith; PAB, postabdomen; PC, pigmented optic cup; PGN, permanent ganglion; PH, pharynx; PHW, pharyngeal wall; PTV, posterior test vesicle; R, rectum; RC, retinal cell; SC, secretory cells; SP, sperm duct; ST stomach; SV, sensory vesicle; T, testis; TF, tail fin; TN, tentacle; TU, tunic; VGN, visceral ganglion; VN, visceral nerve; YC, yolky cells connected with the growth of the postabdomen; YK, yolk granules.